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IS 13360-5-19 (1999): Plastics - Methods of Testing, Part 5: Mechanical Properties, Section 19: Determination of Resistance of Plastic Materials to Abrasion [PCD 12: Plastics]



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भारतीय मानक

प्लास्टिक — परीक्षण पद्धतियाँ

भाग 5 यांत्रिक गुणधर्म

अनुभाग 19 प्लास्टिक सामग्रियों की अपघर्षण हेतु प्रतिरोधिता ज्ञात करना

Indian Standard

PLASTICS — METHODS OF TESTING

PART 5 MECHANICAL PROPERTIES

Section 19 Determination of Resistance of Plastic Materials to Abrasion

ICS 83.080; 19.060

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Methods of Test for Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

The measurement of the resistance to abrasion of plastic materials is very complex. The resistance to abrasion is affected by many factors such as the physical properties of the polymeric material, particularly hardness, resilience and the type and degree of added filler such as cellulose fibre or pigment. Resistance to abrasion is also affected by conditions of the test, such as the nature of the abradant, action of the abradant over the area of the specimen abraded, and development and dissipation of heat during the test cycle.

Although laboratory measurement of the resistance to abrasion of a given material may be closely allied, in some instances, to material quality, results shall not be used as an absolute index of ultimate life. This is particularly in view of end-use performance depends upon the ability to assess those actions in service which affect durability, and it is for this reason that many different types of testing machines have been employed. Results from machines such as those described in this standard are of value chiefly in the development of materials, and shall not be used without qualification as a basis for commercial comparisons.

The procedures described in these test methods have been prepared in an attempt to standardize methods of test used for measuring abrasion resistance of plastic materials. It is believed that the standardization of such test methods, plus the addition of new test methods as developed, and subsequent choice of that test method most closely simulating service conditions, will provide a means of measuring durability of plastic materials for a given application. These test methods have been prepared in an attempt to attain these objectives.

While preparing this standard considerable assistance has been derived from ASTM D 1242-95a 'Standard test methods for resistance of plastic materials to abrasion' issued by American Society for Testing and Materials (ASTM), USA.

In reporting the results of a test of analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

PLASTICS — METHODS OF TESTING

PART 5 MECHANICAL PROPERTIES

Section 19 Determination of Resistance of Plastic Materials to Abrasion

1 SCOPE

1.1 This standard (Part 5, Section 19) covers the determination of the resistance to abrasion of flat surfaces of plastic materials, measured in terms of volume loss, by two different types of abrasion-testing machines as follows.

1.1.1 *Test Method A* — Loose abrasive.

1.1.2 *Test Method B* — Bonded abrasive on cloth or paper abrasive tape.

2 NORMATIVE REFERENCES

The following standard contains provisions which, through reference in this text, constitutes provisions of the standard. At the time of publication, the edition indicated was valid. The standard is subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
2828 : 1964	Glossary of terms used in plastics industry

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 2828 and the following shall apply.

3.1 Resistance to Abrasion

The ability of a material to withstand mechanical action such as rubbing, scrapping, or erosion, that tends progressively to remove material from its surface.

4 CONDITIONING

Condition the test specimens at $27 \pm 2^\circ\text{C}$ and 65 ± 5 percent relative humidity for not less than 40 h prior to test. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ and ± 2 percent relative humidity.

4.1 Test Conditions

Conduct tests in the standard laboratory atmosphere of $27 \pm 2^\circ\text{C}$ and 65 ± 5 percent relative humidity. In cases of disagreements, the tolerances shall be $\pm 1^\circ\text{C}$ and 2 percent relative humidity.

TEST METHOD A — LOOSE ABRASIVE

5 APPARATUS

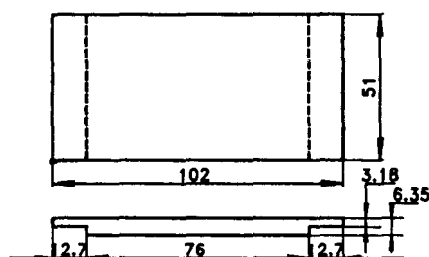
5.1 The apparatus shall consist of a rotating disk, a specimen mounting plate holder, a cam arrangement for actuating the specimen holder, hopper and distributor for feeding fresh abrasive, hopper for collecting used abrasive, revolution counter, an added weight of 4.5 kg, and suitable mechanism for driving the disk at 23 r/minute and the specimen holder at 32 r/minute.

5.2 Metal Plate

63.5 mm $\times$ 88.9 mm $\times$ 1.6 mm (± 0.05 mm), for adjusting height of drop.

5.3 Specimen Mounting Plate

Made of aluminium in accordance with Fig. 1 for mounting test specimens.



All dimensions in millimetres.

FIG. 1 SPECIMEN MOUNTING PLATES (ALUMINIUM)

5.4 Analytical Balance

For weighing specimen to a precision of 0.001 g.

5.5 Aluminium Oxide Grit

Or other abradant, as specified.

5.6 Suitable Adhesive

For adhering test specimens to the specimen plate.

6 TEST SPECIMENS

6.1 The test specimen shall measure 50.8 ± 0.4 mm $\times$ 76.2 ± 0.4 mm and shall be mounted face up on the raised 50.8 mm $\times$ 76.2 mm portion of the specimen

mounting plate by means of a suitable adhesive. Good adhesion can be obtained by holding the mounted specimen for 24 h under a 2.3 kg weight in the conditioning room.

6.2 The required number of specimens for each test shall be indicated in the material specifications. In the event the material specifications omit this requirement, the material shall be sampled in triplicate, and duplicate measurements shall be made on each specimen. The average of the six measurements shall be taken as the abrasion loss for the material.

7 PROCEDURE

7.1 Determine the density of the material to be tested in accordance with standard analytical procedures.

NOTE — If the specimen as received is not homogeneous, but possesses a surface that differs from the body or core, determine the density of the surface alone. If abrasion is to be carried beyond this surface into the body, then determine also the density of the latter and calculate and report the abrasion resistance of the two components separately.

7.2 Fill the abrasive container with the grit and adjust the rate of feed to 44 ± 2 g/minute.

NOTE — Feed rate may be measured by holding a tared Petri dish under the abrasive distributor for one minute, while the machine is running, and weighing the amount of grit delivered. Feed rate may be adjusted by repositioning the abrasive feed impeller shaft upon which the abrasive hopper is mounted, either upward or downward. Fresh grit shall always be used, and no attempt make to reclaim or run used grit.

7.3 Weigh the mounted test specimen to the nearest 0.01 g, and attach to the specimen plate holder by means of the end clamp provided.

7.4 Place the weight on the specimen shaft, brush off grit under the specimen, place the 1.6 mm spacer under the specimen with the larger dimension on the surface of the rotating disk, and adjust the cam follower to this maximum lift. Remove the spacer.

7.5 Set the counter for 1 000 revolutions, and run the machine.

7.6 When the machine has stopped, check to see that the revolution counter has returned to zero, remove the mounted specimen, clean with a filtered air blast, and reweigh.

7.7 Inspect the abraded specimen for imbedded grit, unevenness on the abraded surface, peeling off of adhesive, chipped corners or edges, or any irregularities affecting loss of weight weighings.

7.8 For continuing runs, reattach the specimen mounting plate to the specimen plate holder, readjust to a 1.6 mm lift as described in 7.4, and repeat the steps given in 7.5, 7.6, and 7.7.

8 CALCULATION

8.1 Calculate the resistance to abrasion or the abrasion loss as the loss in volume at 1 000 revolutions, as follows:

$$\text{Volume loss, cm}^3 = \frac{M_1 - M_2}{D}$$

where

M_1 = initial mass, g;

M_2 = mass after abrasion, g; and

D = density of the material being abraded.

9 REPORT

The test report shall include the following information:

- The resistance to abrasion or the abrasion loss in volume at 1 000 revolutions, as calculated in 8.1;
- The average volume loss in cubic centimeters at 1 000 revolutions for the three specimens tested in duplicate; and
- The name and grade of abrasive grit employed in making the test.

NOTE — It shall be noted that abrasion loss can be expressed in other ways, using the data given above. For instance, the average loss in thickness of the abraded test specimen can be calculated by dividing the loss in volume by the area of the abraded specimen.

TEST METHOD B — BONDED ABRASIVE ON CLOTH OR PAPER (ABRASIVE TAPE)

10 APPARATUS

10.1 The apparatus shown with a schematic arrangement in Fig. 2 shall consist of the following.

10.1.1 A continuous link belt with flat metal carrier plates upon which test specimens and zinc calibration standards may be mounted, and a constant-speed mechanism to provide a rate of travel of 2 m/minute for the specimens.

10.1.2 A carriage assembly consisting of supply and take up drums for the abrasive tape, including necessary guides and rollers for maintaining uniform tension, the entire carriage being mounted on rolls so as to move freely in either direction, with the abrasive kept in contact with the specimen by means of a dead weight attached to the carriage by a cable-spring-pulley arrangement. The constant-speed drive is designed to provide for continuous travel of the abrasive tape at a rate of 0.5 m/min. This motion in opposition to that of the specimens provides a total rate of slip of 2.5 m/min.

10.2 Specimen Mounting Plates

Made of aluminium in accordance with Fig. 3 for mounting nonrigid or other specimens which require a rigid support.

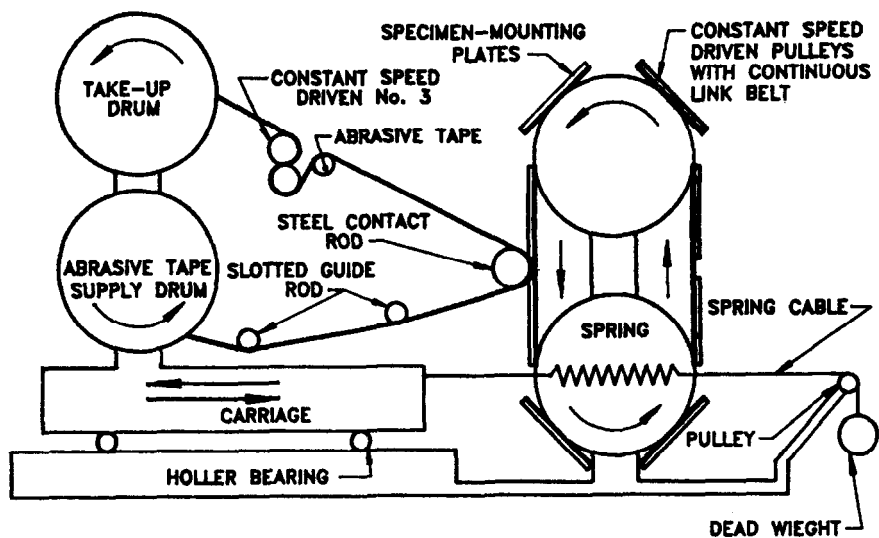
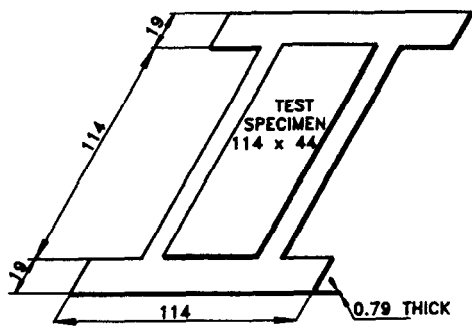


FIG. 2 SCHEMATIC DRAWING OF BONDED ABRASIVE ABRADING MACHINE



All dimensions in millimetres.

FIG. 3 SPECIMEN MOUNTING PLATE (ALUMINIUM)

10.3 Suitable Adhesive

For adhering test specimens to the specimen mounting plates.

10.4 Bonded Abrasive Cloth or Paper (Abrasive Tape)

Of agreed-upon specifications in rolls 50.8 mm wide.

10.5 Zinc Calibration Specimens

Fabricated as shown in Fig. 4.

10.6 Laboratory Balance

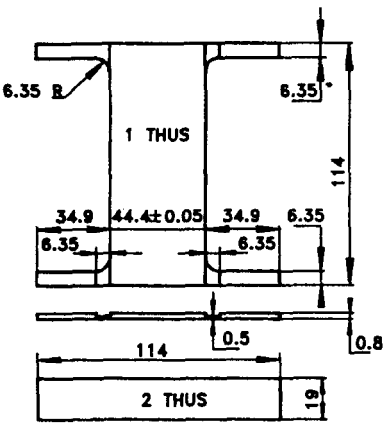
For weighing specimens (including specimen mounting plates when used) to a precision of 0.01 g or better, as required by precision of the test.

10.7 Die

Or other means for cutting nonrigid specimens to the required dimensions.

11 TEST SPECIMENS

11.1 The test specimens shall measure $44.5 \pm 0.25 \text{ mm} \times 114.3 \pm 0.25 \text{ mm}$, and shall be prepared



All dimensions in millimetres.

FIG. 4 ZINC CALIBRATION SPECIMEN

for attachment to the machine. Nonrigid or fragile specimens shall be mounted by means of an adhesive to the aluminium specimen mounting plates. Good adhesion can be obtained by holding the mounted specimen for 24 h under a 18 kg weight in the conditioning room. Rigid specimens of at least 1.6 mm in thickness can be directly mounted (without an adhesive) on the carrier plates of the link belt by means of two flat-headed machine screws (4-40) located on the long axis of each plate, along the center point of the plate, and countersunk below the thickness of the surface to be abraded.

11.2 At least one zinc calibration standard shall be abraded with each group of test specimens making up a 'run' on the abrasion machine. The machine is provided with eight specimen-carrying plates.

11.3 The required number of specimens for each abrasion test shall be indicated in the material specifications. In the event the material specifications omit this requirement, three abrasion specimens shall

be prepared from each lot or sub-lot, and the average of the three shall be taken as the abrasion loss for the lot or sub-lot.

12 PROCEDURE

12.1 Calibrate the abrasive tape to be used by selecting a roll at random from each package of eight or ten rolls, and make an abrasion test on this roll, using four standard zinc specimens that have been previously run with abrasive tape of known characteristics. Then adjust the number of cycles to be used for a 'run' to bring the abrasive effect of the tape within the proper range of loss on the zinc specimens.

NOTE — The grade of the abrasive tape (type and grit size), the weight on the carriage, and the length of time of abrasion can be varied in this apparatus to fit the test to particular purposes. Two references procedures are given below that have been found desirable for the use of coarse grit and fine grit abrasive, respectively.

- i) *Coarse Grit* — This procedure is based upon use of OE Flint abrasive paper 13.6 kg load on the carriage, and a number of abrasion cycles (complete revolutions of the link belt) which will produce an average loss of 0.525 ± 0.025 g on the zinc calibration specimens. The required number of cycles (approximately 60) must be varied, because of variations in the sandpaper. If it is desired to vary the test conditions, the proper loss on the zinc specimens for OE sandpaper can be calculated by referring to curves similar to those shown in Fig. 5 (zinc comparison standard, relation between abrasion loss and abrasion time) and in Fig. 6 (zinc comparison standard, relation between abrasion loss and force on the carriage). If other abrasive tapes are used, the proper loss on the zinc standard for the desired test characteristics must be determined by experiment and comparison.
- ii) *Fine Grit* — This procedure is based upon use of 11/0-500 Flint abrasive paper (snuffing paper), 13.6 kg load on the carriage and a number of abrasion cycles which will produce an average loss of 0.175 ± 0.010 g on the zinc calibration specimens. The required number of cycles is approximately 70. It is often desirable to vary the number of cycles to accommodate the amount of material that may be removed from the test specimens. The proper weight loss on the zinc standard for the desired test shall be determined by experiment from which data similar to those given in Fig. 5 and 6 may be developed.

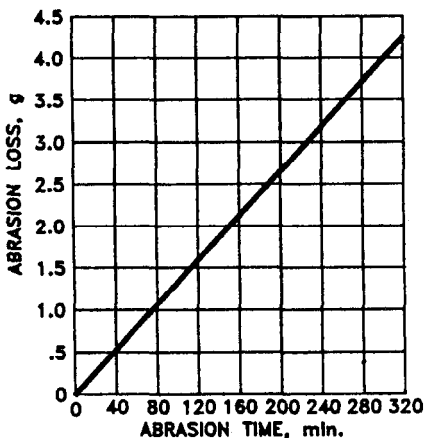


FIG. 5 ZINC COMPARISON STANDARD — RELATION BETWEEN ABRASION LOSS AND ABRASION TIME

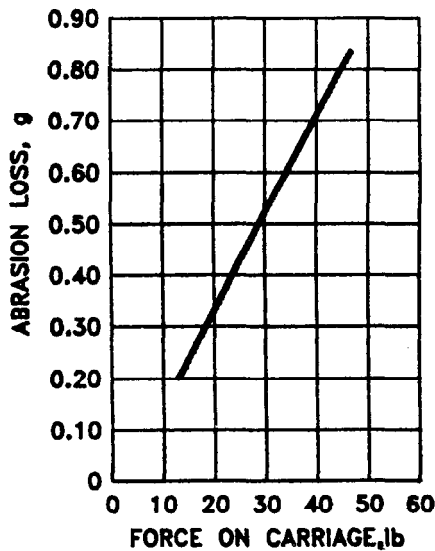


FIG. 6 ZINC COMPARISON STANDARD — RELATION BETWEEN ABRASION LOSS AND FORCE ON THE CARRIAGE

12.2 Cut two shims, each 127 mm long $\times$ 16 mm wide from the material to be tested, to accompany each abrasion specimen. If this is not feasible, use similar material of the same thickness.

12.3 Determine the density of the material to be abraded in accordance with the standard analytical procedure.

NOTE — If the specimen as received is not homogeneous, but possesses a surface which differs from the body or core, determine the density of the surface alone. If abrasion is to be carried beyond this surface into the body, then determine also the density of the latter, and calculate and report the abrasion resistance of the two components separately.

12.4 When the specimens have been prepared and conditioned (are ready for mounting on the abrader) weigh them and the zinc standard to the nearest 0.01 g for the coarse-grit test, or to the nearest 0.001 g for the fine-grit test. Mount the specimens on the carrier plates of the abrader with a shim at each end of each specimen. The purpose of these shims is to serve as bumper strips, leading the abrasive contact roll on and off the specimens without damaging its edges.

12.5 Place the weights on the yoke of the carriage. Unless otherwise specified, use a 11.4 kg weight to provide a total force of 13.6 kg acting on the carriage, since the hook, yoke, and platform of the machine weigh 2.3 kg.

12.6 Set the counter of the machine to zero and run the abrasion test.

12.7 After the required number of cycles has been run, remove the mounted specimens and calibration standards, clean with a filtered air blast, and reweigh.

12.8 If the specimens are to be retested to determine the abrasion resistance below the surface or at various depths, they may be replaced on the machine and run for additional cycles as required.

12.9 In the case of very hard materials, such as zinc, a gasket of friction material may have to be used between the clamps and the specimen to avoid slippage. If different specimens are being tested, stagger the arrangement. No part of the shim shall protrude over the edge of the conveyor plate. Check the sand paper carriage, springs, and pulleys for freedom of movement. After the test has been started, be sure that the abrasive tape is abrading all of the surface of the specimen.

NOTE — A single cycle of abrasion will usually reveal areas of the specimen not contacted by the abrasive. If only one side (more or less) is abraded, shimming can help in obtaining abrasions across the full width. When using the fine-grit test on rigid materials, it has been found helpful to employ a contact roll having a 1.6 mm thick cover of butyl rubber (with the same outside diameter as the standard steel roll). In this way general contact with surfaces having minor waviness (orange peel) is improved.

12.10 Major surface irregularities are cause for rejection of the specimen for this test. Observe the test frequently to see that specimens and shims do not pull away from the specimen plate or clamps. Keep the specimens free from larger particles of dirt and grit.

12.11 If, at the end of the test, the loss on the zinc calibration standard is not in proportion to the limits specified, it shall be assumed that the abrasive tape or the abrasion machine is out of calibration, and the test shall be repeated.

12.12 Be certain that the loss on the test specimen represents only material abraded, and that no loss is due to peeling off of adhesive, or broken corners and edges of the specimen. Cut test specimens from a portion of the sample that is representative of the

material to be tested. Check the abrasion machine for level and alignment before each test.

13 CALCULATION

13.1 Calculate the resistance to abrasion or the abrasion loss as the loss in volume for X cycles using Y grade of abrasive tape and a 13.6 kg load on the carriage, as follows:

$$\text{Volume loss, cm}^3 = \frac{M_1 - M_2}{D}$$

where

M_1 = initial mass, g;

M_2 = mass after abrasion, g; and

D = density of the material being abraded.

NOTE — In the case of nonrigid specimens M_1 and M_2 include the mass of the aluminium specimen-mounting plate and the adhesive used.

14 REPORT

The test report shall include the following information:

- a) The resistance to abrasion or the abrasion loss as the loss in volume for X cycles using Y grade of abrasive tape and a 13.6 kg load on the carriage, as calculated in 13.1;
- b) The average volume loss in cubic centimeters for the three specimens tested;
- c) The number of cycles used;
- d) The weight used, in kg;
- e) The name and grade of abrasive tape employed in making the test; and
- f) The loss, in grams, obtained on the zinc calibration standards run at the same time.

NOTE — It shall be noted that abrasion loss can be expressed in other ways, using the data given above. For instance, the average loss in thickness of the abraded test specimen can be calculated by dividing the loss in volume by the area of the abraded specimen.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'

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